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SUBJECT—

TITLE

COMPOSITION STUDIES OF THE 1940 SEASON

MODOC NATIONAL FOREST

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by
J. W. Johnson
Berkeley, California
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DECEMBER 17, 1940

COMPOSITION STUDIES OF THE 1940 SEASON,

MODOC NATIONAL FOREST

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COMPOSITION STUDIES OF THE 1940 SEASON, MODOC NATIONAL FOREST

INTRODUCTION

In the autumn of 1940 studies of the compositions of insect infestations in the ponderosa pine timberlands of the Modoc National Forest, California, were continued by the Bureau of Entomology and Plant Quarantine. The work for the studies was performed in the vicinity of the Hackamore Field Laboratory by J. W. Johnson under the direction and supervision of Dr K. A. Salman during the period from October 2 to November 9. In this work the Bureau personnel was assisted by a crew of two CCC enrollees from the Hackamore CCC camp.

To the successful completion of the composition studies program the cooperative action of the Modoc Forest Service Office, the administrative officers of the Hackamore CCC camp, and the Shaw-Bertram Lumber Company all contributed The help of these agencies is gratefully acknowledged.

WORKING AREA

Location

It was planned to use the same general area as a source of trees in the 1940 studies as had been used in the previous year. This area is the forested land lying in the southwest one-quarter of the Badger Township (T 44 N, R 8 E, M.D.M.), especially the land along the Hackamore-Badger-Brown's Well roads in sections 20, 29 and 31. But the infestations of 1940 winter brood trees proved to be few and scattered in this area, so that it became necessary to extend the search for trees to the lands along all the usable roads within and adjacent to the Badger Township.

Method of Locating Trees

The trees carrying 1940 winter broods were located both by cruising on foot and from a slowly moving vehicle. When the infestation proved to be light, the use of a pickup for the cruising was adopted to speed up coverage of the area. In cruising, the roads were used as cruise lines. A strip approximately 10 chains in width along each side of the road was carefully observed for trees, all likely trees being checked.

Area Covered

By such methods, slightly over thirty miles of roadside strip about 20 chains in width were cruised This amounts to approximately 4800 acres. The following roads were cruised.

Hackamore-Badger Well road from a point at south boundary of township near center of Section 31 northeast 2.5 miles to its intersection with the Brown's Well-Badger Well road Along the Brown's Well-Badger Well road 3 5 miles toward and slightly past Brown's Well Along the old railroad grade connecting the Hackamore-Badger Well road withethe Brown's Well-Badger Well road 1.31 miles. Along the Wart-on-Tree road from Badger Well southeast 6.25 miles to Flag Spring intersection. Along the Badger Well-Mowitz road from Badger Well 4.7 miles to the Flag Spring-Mowitz intersection. From the Wart-on-Tree-Flag Spring intersection north along the east boundary of Badger township to Mowitz Butte 8.50 miles. Along the old control road branching off Wart-on-Tree road .95 miles. For one mile along the old railroad spur branching off the Hackamore-Badger Well road 3/4 of a mile inside the south boundary of the township. From Brown's Well northward on road connecting with Wart-on-Tree road 1.35 miles. From Brown's Well along road to sheep camp .10 miles.

In addition to the trees utilized in the Badger area, the analyses of five winter trees located on the Timber Mountain 40-acre tree susceptibility plot and on the 10-acre MC-3 tree susceptibility plot were included in the 1940 composition series. The acreage of these two plots brings the acreage cruised to approximately 4850 acres.

Infestation Characteristics

The infestation of the 1940 winter season presented a distinctly different aspect from that of 1939.

Number of Trees

The first and most evident difference was the much smaller number of trees containing winter broods in the current season In a strip about 30 miles in length, thirty-eight 1940 winter brood trees were found. This compares with about seventy-one trees that were found in a strip about 5 miles in length in 1939 The ratio of loss in trees per acre in 1940 as compared to the loss in trees per acre in 1939 was about 1 to 10.

Tree Size

A second feature of the 1940 winter losses was the occurrence of the losses in trees of a larger average diameter than in the previous season. Thus while the ratio of loss in winter trees per acre in 1940 as compared to

THAT OF 1939 WINTER APPEARS TO HAVE BEEN ABOUT 1 TO 10, THE LOSS OF VOLUME IN B.M PER ACRE IN 1940 AS COMPARED TO THE LOSS IN VOLUME B.M. PER ACRE IN 1939 SEEMS TO HAVE BEEN ONLY 1 TO 6 (SEE TABLE 1, LAST COLUMN). WHEN THE DIFFERENCE IN TREE SIZE DURING THE TWO YEARS IS EXPRESSED IN TERMS OF THE AVERAGE SIZE IN BOARD MEASURE VOLUME OF EACH TREE LOST, THE TREES DYING IN 1940 HAD AN AVERAGE VOLUME B.M OF 968.4 FEET AS COMPARED TO AN AVERAGE VOLUME B.M. OF 564.5 FEET FOR THE TREES KILLED IN 1939.

TABLE 1. B.M. VOLUME OF LOSS PER ACRE ATTRIBUTED TO FOUR SPECIES* INITIATING THE INSECT ATTACKS

YEAR	ACREAGE	M.C.	D.B.	I.O.	D.M.	ALL SPECIES
**1940	4,850	6.71	1.31	.57	--	8.6
1939	800	18.64	26.74	3.08	1.65	50.1

* SPECIES:
M.C. - MELANOPHILA CALIFORNICA VAN DYKE
D.B. - DENDROCTONUS BREVICOMIS LEC.
I.O. - IPS OREGONI (EICH.)
D.M. - DENDROCTONUS MONTICOLAE HOPK.

** THESE FIGURES FOR 1940 ARE PREPARED FROM THE BADGER TOWNSHIP LOSSES AND THE LOSSES OF FIVE TREES ON THE TREE SUSCEPTIBILITY PLOTS ON TIMBER MOUNTAIN AND MC-3.

GROUPING

A THIRD DIFFERENCE BETWEEN THE 1939 AND 1940 INFESTATIONS WAS OBSERVABLE IN THE NUMBER OF TREES OCCURRING AS PARTS OF GROUPS AND IN THE NUMBER OF GROUPS IN THE TWO YEARS IN THE 1940 SEASON 25.6 PERCENT OF THE WINTER TREES OCCURRED AS PARTS OF GROUPS, AND ALL OF THESE WERE ASSOCIATED WITH GROUP INFESTATIONS OF THE PAST SUMMER, WITH THE EXCEPTION OF ONE WINTER GROUP COMPOSED OF TWO ADJACENT FLATHEAD TREES. IN 1939, 66.2 PERCENT OF THE WINTER TREES OCCURRED IN GROUPS OR AS PARTS OF GROUPS, WITH MORE WINTER TREES OCCURRING IN WINTER GROUPS (36.6%) THAN AS PARTS OF SUMMER GROUPS (29.6%). THE GROUPING TENDENCY THUS REACHED ITS CLIMAX IN 1939 SUMMER AND WINTER AND HAS FALLEN OFF GREATLY SINCE, ESPECIALLY AFTER 1940 SUMMER, ESPECIALLY AFTER 1940 SUMMER (SEE TABLE 2).

THE NUMBER AND THE SIZE OF THE GROUPS DIFFERED CORRESPONDINGLY IN 1940 AND IN 1939, AS IS SHOWN IN TABLE 2. IN 1940 HALF AS MANY GROUPS WERE ENCOUNTERED AS IN 1939. THE LARGEST GROUP OF THE 1940 SEASON WAS ONE OF SIX TREES (ONE OR TWO OF WHICH MAY HAVE BEEN 1939 WINTER TREES). THE LARGEST 1939 GROUP CONTAINED FIFTEEN TREES.

TABLE 2. NUMBER OF GROUPS OBSERVED IN THE 1940 AND 1939 SEASONS

YEAR	SEASON	% OF WINTER TREES IN GROUPS	NUMBER OF TREES IN GROUP							TOTAL NO. GROUPS
			2	3	4	5	6	7	15	
1940	SUMMER	20.9	1	2		2	1			6
1940	WINTER	4.7	1							1
1939	SUMMER	29.6	2	3		1			1	7
1939	WINTER	36.6	1	3	2			1		7
1940	BOTH	25.6	2	2		2	1			7
1939	BOTH	66.2	3	6	2	1		1	1	14

TOPKILLS

A FOURTH DIFFERENCE BETWEEN THE INFESTATIONS WAS THE DIFFERENCE IN THE NUMBER OF TOPKILLS CONTRIBUTING TO THE WINTER LOSSES. TOPKILLS CONTRIBUTED 21 TREES, OR 48.8 PERCENT OF THE WINTER LOSSES IN 1940. IN 1939 TOPKILLS PROVIDED 14 TREES OR 19.7 PERCENT OF THE WINTER LOSSES.

SPECIES RELATIONS

IN MAKING AN ANALYSIS OF SPECIES RELATIONS AND FACTORS ASSOCIATED WITH THE DEATH OF THE TREES, ATTENTION WAS GIVEN ONLY TO THE ENTOMOLOGICAL FACTORS ACCOMPANYING THE DEATH OF THE TREES. BUT IT WAS RECOGNIZED THAT OTHER FACTORS THAN THE ENTOMOLOGICAL MAY HAVE PREDISPOSED THE TREES TO ATTACK BY INSECTS OR TO THE SUCCESSFUL DEVELOPMENT OF THE BROODS WITHIN THEM. IN THE CASE OF EACH TREE AN EFFORT WAS MADE DURING THE EXAMINATION IN THE FIELD TO DETERMINE WHICH SPECIES OF INSECT APPEARED TO HAVE ATTACKED FIRST OR BECOME ACTIVE FIRST IN THE SUCCESSION OF INSECT ATTACKS ASSOCIATED WITH THE FINAL TREE DEATH. THE INFESTATION TYPES WERE THEN CLASSIFIED AND SEGREGATED DEPENDING ON THE SPECIES CONSIDERED TO BE THE INITIAL ONE IN THE INSECT SUCCESSION. BUT THE POSSIBILITY THAT THE SUPPLEMENTAL ATTACKS OF OTHER SPECIES MAY HAVE BEEN ESSENTIAL IN THE PROCESSES LEADING TO THE VISIBLE DEATH OF THE TREE WAS REALIZED.

IN THE 1939 ANALYSES FOUR SPECIES APPEARED TO HAVE ACTED AS INITIATORS OF INSECT SUCCESSIONS IN TREES. THESE WERE *DENDROCTONUS BREVICOMIS* LEC., *MELANOPHILA CALIFORNICA* VAN DYKE, *IPS OREGONI* (EICH.), AND *DENDROCTONUS MONTICOLAE* HOPK. IN 1940 THE WINTER INFESTATION SHOWED ONLY *D. BREVICOMIS*, *M. CALIFORNICA*, AND *I. OREGONI* AS INITIATORS OF ATTACKS.

AS INDICATED IN THE SECTION ON THE NUMBER OF TREES IN THE INFESTATIONS, THE VISIBLE INFESTATION OF 1940 WINTER TREES APPEARED TO HAVE FALLEN, IN TERMS OF B.M. VOLUME, TO PERHAPS ONE-SIXTH OF THE LEVEL OF THE 1939 VISIBLE WINTER INFESTATION THIS DROP IN INFESTATION AFFECTED ALL THE FOUR SPECIES, ALL OF THEM SHOWING CONSIDERABLE DECLINES IN THE AMOUNT

OF THEIR INFESTATION IN B.M. VOLUME PER ACRE IN 1940 AS COMPARED TO 1939. THE DROP IN INFESTATION, HOWEVER, FOR THE FOUR SPECIES WAS NOT LINEAR WITH THE AVERAGE DROP OF THE INFESTATION AS A WHOLE. M. CALIFORNICA AND IPS OREGONI INFESTATIONS FELL OFF, BUT LESS RAPIDLY THAN THE AVERAGE, AND D. BREVICOMIS AND D. MONTICOLAE FELL OFF MUCH MORE RAPIDLY. TABLE 1 SHOWS THE TREND OF THE LOSSES FOR EACH OF THE FOUR SPECIES, AND THE AVERAGE FOR ALL LOSSES. THE FIGURES, HOWEVER, MAY BE ONLY SUGGESTIVE BECAUSE OF THE SMALL NUMBERS AND VOLUMES OF TREES THAT ARE BEING DEALT WITH, ESPECIALLY FOR 1940, AND BECAUSE OF THE UNCERTAINTY OF THE VALIDITY OF THE SAMPLES THAT ARE PROVIDED BY SUCH A SERIES OF ANALYSES.

BECAUSE OF THE UNEQUAL DECLINE FROM 1939 TO 1940 IN THE INFESTATIONS PER ACRE FOR THE FOUR SPECIES, THE RELATIVE FREQUENCY WITH WHICH EACH INITIATING SPECIES OCCURRED IN THE TREES OF 1940 AS COMPARED TO 1939 CHANGED ALSO. CERTAIN DIFFERENCES IN THE RELATIVE FREQUENCY OF THE SPECIES BETWEEN TWO YEARS WERE NOTED (SEE TABLES 3 AND 5).

DENDROCTONUS BREVICOMIS AS AN INITIATING SPECIES ATTACKED 23.3 PERCENT OF THE TREES IN 1940 AS COMPARED TO 63.4 PERCENT IN THE TREES OF 1939. BIT ITS PERCENTAGE OCCURRENCE IN ALL INFESTATIONS, INITIALLY OR SUPLEMENTALLY, SUBFERED A DROP OF ONLY 0.9 PERCENT TO 97.7 PERCENT FOR 1940 AS COMPARED TO 98.6 PERCENT IN 1939.

MELANOPHILA CALIFORNICA WAS THE FIRST SPECIES TO BECOME SUCCESSFUL IN 69.8 PERCENT OF THE 1940 WINTER TREES. THIS CONTRASTS WITH AN INCIDENCE OF 26.8 PERCENT IN THE PREVIOUS YEAR. THIS INCREASE, OF COURSE, IS ONLY RELATIVE TO THE OCCURRENCE OF THE OTHER SPECIES, FOR AS HAS BEEN INDICATED, THE MELANOPHILA INFESTATION IN VOLUME B.M. PER ACRE FELL IN 1940 TO SLIGHTLY MORE THAN ONE-THIRD OF ITS LEVEL IN 1939.

IPS OREGONI INITIAL ATTACKS SHOW AN INCREASE, ALSO, RELATIVE TO THE OTHER SPECIES TO 7.0 PERCENT IN 1940 FROM 2.8 PERCENT IN 1939. BUT THE SAME INCREASE OF IPS AS AN INITIATING SPECIES IS NOT SHOWN IN THE GENERAL PERCENTAGE OF ITS OCCURRENCE IN ALL TYPES OF INFESTATION FOR THE SAME YEAR. FOR IN 1940 THE INCIDENCE OF OCCURRENCE OF THE SPECIES IN ALL INFESTATIONS, INITIALLY OR SUPPLEMENTALLY, WAS 46.5 PERCENT AS CONTRASTED TO 53.5 PERCENT IN 1939. THESE RELATIVE PERCENTAGES ALSO MAY BE COMPARED TO THE IPS LOSSES PER ACRE IN B.M. VOLUME, WHICH IN 1940 WINTER WERE A LITTLE LESS THAN ONE-FIFTH OF THOSE IN 1939 WINTER.

IN THE VICINITY OF HACKAMORE IN 1940 THERE APPEARED TO BE AN ACTUAL INCREASE IN IPS ACTIVITY. THIS LOCAL INCREASE SEEMED TO BE ASSOCIATED WITH THE CUTTING OPERATIONS CARRIED ON THERE DURING THE SPRING MONTHS. AFTER CESSATION OF CUTTING AND THE REMOVAL OF THE LOGGING OPERATIONS TO ANOTHER AREA, IPS TOPKILLING OF A NUMBER OF TREES IN THE FOREST ADJACENT TO THE CUT AREA SHOWED UP DURING THE SUMMER.

DENDROCTONUS MONTICOLAE FROM 1939 TO 1940 DISAPPEARED FROM THE PICTURE. IN 1940 THE SPECIES WAS ENCOUNTERED ONLY IN A FEW SCATTERED ATTACKS IN CONJUNCTION WITH OTHER SPECIES. THE POPULATIONS SEEM TO HAVE BEEN AT A VERY LOW LEVEL. IN 1939 D. MONTICOLAE WAS STILL SOMEWHAT ACTIVE.

Table 3

Relative Occurrence of Four Species in 1939 and 1940 as Initiators of Attacks.
(Given in terms of the percentages of total number of trees analyzed for each year)

Year	Condition	Single trees					Group trees					All trees				
		Mc	Db	Io	Dm	Total	Mc	Db	Io	Dm	Total	Mc	Db	Io	Dm	Total
1940	TK	39.5	4.7	4.7	-	48.8	-	-	-	-	-	39.5	4.7	4.7	-	48.8
1940	No TK	25.6	-	-	-	25.6	4.7	18.6	2.3	-	25.6	30.2	18.6	2.3	-	51.1
1940	All	65.1	4.7	4.7	-	74.4	4.7	18.6	2.3	-	25.6	69.8	23.3	7.0	-	100.0
1939	TK	8.5	2.8	1.4	2.8	15.5	1.4	2.8	-	-	4.2	9.9	5.6	1.4	2.8	19.7
1939	No TK	11.3	4.2	-	2.8	18.3	5.6	53.5	1.4	1.4	62.0	16.9	57.7	1.4	4.2	80.3
1939	All	19.8	7.0	1.4	5.6	33.8	7.0	56.3	1.4	1.4	66.2	26.8	63.4	2.8	7.0	100.0

Abbreviations:

TK - Topkilled trees
Mc - Melanophila californica Van Dyke
Db - Dendroctonus brevicomis Lec.
Io - Ips oregoni (Eich.)
Dm - Dendroctonus monticolae Hopk.

THREE OTHER SPECIES APPEARED IN THE INFESTATIONS OCCASIONALLY IN A SUPPLEMENTARY ROLE.

IPS EMARGINATUS (LEC.) OCCURRED ONLY OCCASIONALLY AND CHIEFLY AS PARENT ADULTS THAT APPEARED TO HAVE ENTERED ABANDONED D. BREVICOMIS AND I. OREGONI GALLERIES FOR PURPOSES OF OVERWINTERING. A FEW BROOD GALLERIES OF I. EMARGINATUS WERE OBSERVED. THERE WAS EVEN LESS OF THIS SPECIES IN 1940 THAN IN 1939.

DENDROCTONUS VALENS LEC. SHOWED UP AS BUTT INFESTATIONS IN MOST OF THE TREES FELLED FOR ANALYSIS. IN A FEW CASES IT WAS FOUND ATTACKING TREES OF VERY POOR APPEARANCE THAT OTHERWISE BORE NO EVIDENCE OF INFESTATION BY OTHER SPECIES. THE 1940 POPULATION LEVEL DID NOT APPEAR TO DIFFER MUCH FROM THAT OF 1939.

MELANOPHILA GENTILIS LEC. INFESTATIONS POSSIBLY WERE ENCOUNTERED IN THREE OR FOUR TREES IN 1939 IN ASSOCIATION WITH THE ATTACKS OF OTHER SPECIES, BUT THE IDENTIFICATION OF THE SPECIES WAS NOT POSITIVE. IN 1940 NO INDICATION WAS FOUND OF THE PRESENCE OF M. GENTILIS IN ANY OF THE TREES.

COMMON INFESTATION TYPES AND SPECIES COMBINATIONS

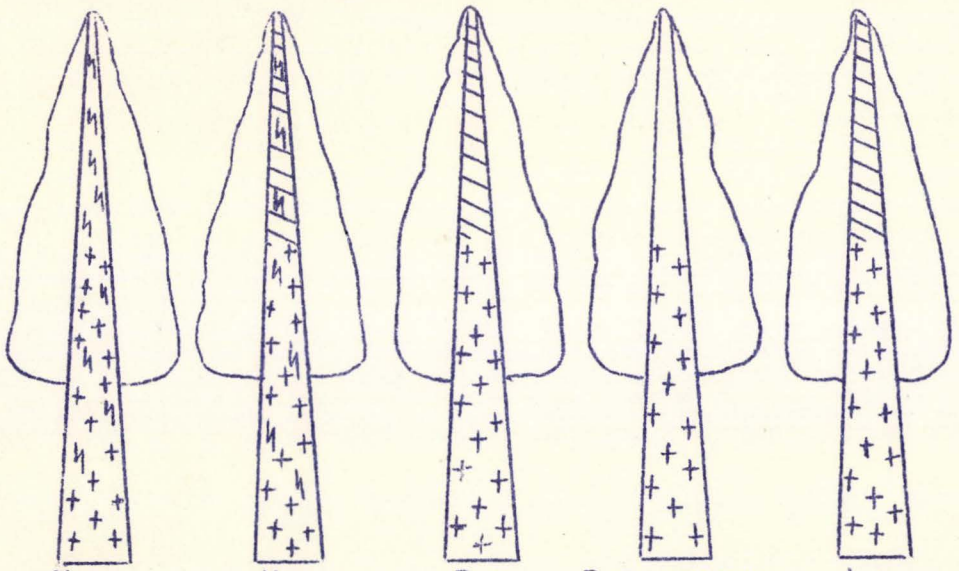
IN BOTH 1939 AND 1940 THE INFESTATIONS FOR THE MOST PART WERE NOT COMPOSED PURELY OF ONE SPECIES, BUT RATHER TWO OR MORE SPECIES WERE GENERALLY MIXED TOGETHER IN THEIR ATTACKS ON ONE TREE. THE SEQUENCE OF ATTACKS OF THE SEVERAL SPECIES VARIED ALSO, MAKING A CONSIDERABLE VARIETY OF INFESTATION COMBINATIONS IN BOTH YEARS. IT IS POSSIBLE, HOWEVER, TO GROUP MOST OF THESE INTO SEVERAL MAIN TYPES ON THE BASIS OF THE TWO OR THREE SPECIES DOMINATING THE INFESTATION IN ANY GIVEN TREE. THE MAIN TYPES OF SPECIES COMBINATIONS IN THE 1939 AND 1940 INFESTATIONS ARE INDICATED IN TABLE 4 AND IN THE SKETCHES OF PLATE 1.

ONE INFESTATION TYPE ENCOUNTERED IN BOTH YEARS, BUT MORE FREQUENTLY IN 1939, WAS THE INFESTED TREE WITH A GREEN TOP. IN 1940 A SMALL NUMBER OF TREES OF THIS TYPE WERE FOUND. THESE AMOUNTED TO ABOUT 16 PERCENT OF THE INFESTED TREES. IN 1939 A LARGER NUMBER WERE ENCOUNTERED - ABOUT 24 PERCENT. IN BOTH YEARS THE D. BREVICOMIS AND D. BREVICOMIS-I. OREGONI TREES MADE UP THE CHIEF SOURCE OF THESE GREEN-TOPPED INFESTATIONS; BUT THERE WAS ONE M. CALIFORNICA TREE IN 1940 AND TWO IN 1939, AND ONE D. MONTICOLAE-D. BREVICOMIS TREE IN 1939 IN THIS TYPE OF INFESTATION.

PLATE 1

A. COMMON INFESTATION TYPES OF THE 1940 SEASON

(+ - D. BREVICOMIS, ⁴ - M. CALIFORNICA, ||| - D. MONTICOLAE, /// - IPS OREGONI.)



M.C.-D.B. 39.5%

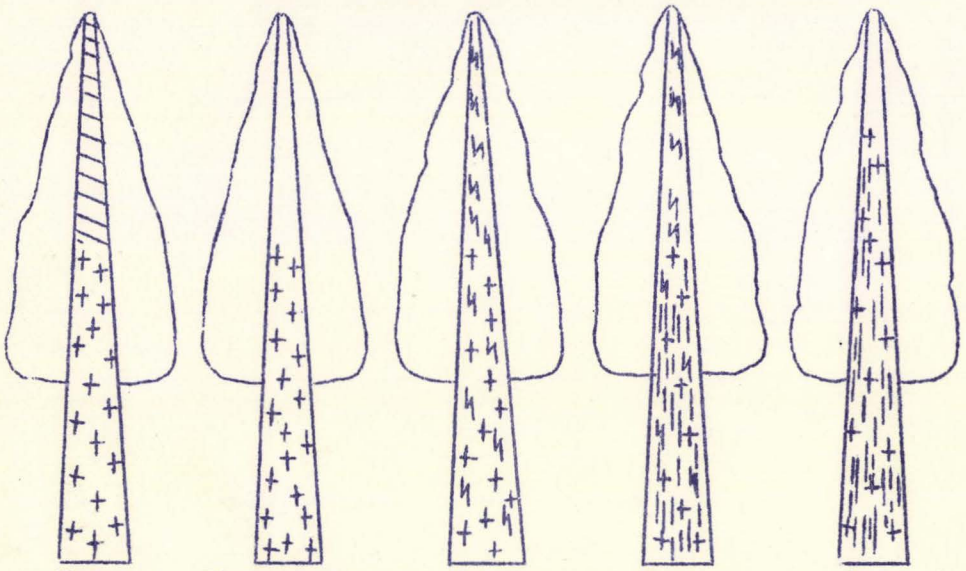
M.C.-D.B.-I.O. 25.6%

D.B.-I.O. 14.0%

D.B.-MOSTLY GREEN TOP. 9.3%

I.O.-D.B. 7.0%

B. COMMON INFESTATION TYPES OF THE 1939 SEASON



D.B.-I.O. 45.1%

D.B.-MOSTLY GREEN TOP. 18.3%

M.C.-D.B. 14.1%

M.C.-D.M.-D.B. 8.4%

D.M.-D.B. 5.6%

THE TREE DIAGRAMS ARE ARRANGED FROM LEFT TO RIGHT IN DECREASING ORDER OF IMPORTANCE IN THE GENERAL INFESTATION. THE SPECIES INITIATING THE INFESTATION IS LISTED FIRST UNDER EACH DIAGRAM. ABBREVIATIONS OF THE SPECIES NAMES ARE: D.B. - DENDROCTONUS BREVICOMIS LEC., M.C.- MELANOPHILA CALIFORNICA VAN DYKE, I.O.- IPS OREGONI (EICH.), D.M.- DENDROCTONUS MONTICOLAE HOPK.

TABLE 4. MAIN INFESTATION TYPES ENCOUNTERED IN 1939 AND 1940

INFESTATION TYPE	NUMBER OF TREES		PERCENT OF TOTAL TREES	
	1940	1939	1940	1939
M.C.-D.B.	17	10	39.5	14.1
M.C.-D.B.-I.O.	11	3	25.6	4.2
M.C.-D.M.-D.B.-MISC.	1	6	2.3	8.4
D.B. ONLY	4	13	9.3	18.3
D.B.-I.O.	6	32	14.0	45.1
I.O.-D.B.	3	2	7.0	2.8
D.M.-D.B.	-	4	-	5.6
ALL*	42	70	97.7	98.6

*ONE PURE INFESTATION OF M.C. IN A 1940 TREE NOT INCLUDED IN THE 1940 TOTAL, AND ONE PURE INFESTATION OF D.M. IN A 1939 TREE NOT INCLUDED IN THE 1939 TOTAL.

DISTRIBUTION OF THE INFESTATION OVER THE AREA

THE DISTRIBUTION OF THE INFESTATION IN 1940 WAS NOT UNIFORM OVER THE BADGER AREA. ON THE WESTERN HALF OF THE TOWNSHIP IT WAS QUITE LIGHT. THE HEAVIEST INFESTATION WAS ALONG THE EASTERN EDGE OF THE TOWNSHIP WHERE THERE WERE FREQUENT 1940 SUMMER GROUPS AND MORE 1940 WINTER TREES THAN FARTHER WEST. THE LOSSES SEEMED TO BE DISTRIBUTED WITHOUT PARTICULAR RELATION TO THE DISTRIBUTION OF THE SITE CLASSES OF THE AREA.

AUTUMN CLIMATIC CONDITIONS

AS A MATTER OF RECORD THE CLIMATIC CONDITIONS PREVAILING DURING THE AUTUMN SHOULD BE NOTED. DURING THE MONTH OF SEPTEMBER A THREE-WEEK PERIOD OF LOW TEMPERATURES AND CLOUDY, RAINY WEATHER BROUGHT THE PROGRESS OF INFESTATIONS ON THE MODOC ALMOST TO A STANDSTILL. AT THIS TIME THERE WERE QUITE A FEW D.B.-IPS GROUP INFESTATIONS THAT WERE IN A CONDITION TO PASS THE 1940 WINTER CARRYING BROODS WITHIN THEM. AT THE END OF SEPTEMBER THE WEATHER CLEARED, THE DAY TEMPERATURES RISING AGAIN INTO THE SEVENTIES. THE WARM, DRY WEATHER PREVAILED FOR THREE WEEKS IN OCTOBER. DURING THIS PERIOD MANY OF THE BROODS EMERGED FROM THE TREES. BUT THE EMERGING BROOD HAD SCARCELY ESTABLISHED ATTACKS ON NEW TREES BEFORE COLD WEATHER WITH RAIN, SNOW, AND SUB-FREEZING TEMPERATURES SET IN. JUST WHAT MAY BE THE FINAL EFFECT OF THIS AUTUMNAL CLIMATIC SEQUENCE UPON THE SUBSEQUENT COURSE OF THE INFESTATION IS NOT KNOWN, HOWEVER.

OTHER INFESTATION RELATIONSHIPS

Comparison of Infestations between the Single Trees and Trees Forming Parts of Groups

When the incidences of the four species, Dendroctonus brevicomis Lec., Melanophila californica Van Dyke, Ips oregoni (Eich.), and Dendroctonus monticolae Hopk. are compared between single tree infestations and group tree infestations for the two years of 1939 and 1940, differences in the incidence of the species as the initiators of attacks, appear between the two types of infestation and for the different years, as may be seen in Table 5.

Dendroctonus brevicomis had a higher incidence in group trees than in single trees, and its incidence in both classes of trees decreased from 1939 to 1940.

Melanophila californica had a higher incidence in single trees than in group trees, and its incidence shows an increase from 1939 to 1940 in both classes.

Ips Oregoni shows its highest incidence in the group trees and shows a slight increase from 1939 to 1940. But it is noteworthy that the Ips oregoni general occurrence in all infestations both as an initiating species and as a supplemental species was less (46.5%) in 1940 than in 1939 (53.5%).

Dendroctonus monticolae disappears from the picture in 1940. In 1939 its incidence was slightly higher in single trees than in group trees.

Table 5. Incidence of Species as Initiators of Infestations in Single Trees and in Trees of Groups
(In percentages of total number of trees in each class)

	Single Trees					Group Trees				
Year	Mc	Db	Io	Dm	Total	Mc	Db	Io	Dm	Total
1940	87.5	6.3	6.3	-	100.0	18.2	72.7	9.1	-	100.0
1939	58.3	29.2	4.2	8.3	100.0	10.6	85.1	2.1	2.1	100.0

Relationship of Melanophila californica to the Group Losses

The occurrence in the group losses of Melanophila californica with an incidence of 10.6% for 1939 and 18.2% for 1940 raises the question of whether these flathead trees may have served as centers of D.B. attack for the development of the groups. The infestation records, however, do

NOT FURNISH A VERY RELIABLE SOURCE OF INFORMATION ON THIS PROBLEM, SINCE IN GENERAL THE ANALYSES OF GROUPS ARE INCOMPLETE WHERE SUMMER TREES ARE INVOLVED. FOR THE MOST PART THE ONLY TREES OF THE SUMMER GROUPS THAT WERE FELLED AND EXAMINED WERE THOSE CARRYING OVERWINTERING BROODS, AND IN MANY CASES DATA ON THE INFESTATIONS OF ADJACENT SUMMER BROOD TREES, WHICH WERE THE FIRST TREES IN THE GROUPS TO BE ATTACKED, WAS NOT SECURED.

WHEN THE ANALYSIS RECORDS WERE CHECKED FOR INFORMATION ON THIS QUESTION OF THE RELATION OF THE MELANOPHILA TREES TO THE FORMATION OF GROUPS, IT WAS FOUND THAT IN 1940, OF THE TWO FLATHEAD TREES OCCURRING WITH ELEVEN WINTER TREE INFESTATIONS IN THE GROUPS, NEITHER SERVED AS A CENTER FOR GROUP DEVELOPMENTS. BUT OF THE SUMMER TREES OCCURRING IN THE 1940 GROUPS, ONE WAS OBSERVED TO CONTAIN A FLATHEAD BROOD, AND IT APPEARED TO HAVE HAD A "KEY" POSITION IN ONE GROUP INFESTATION. IN 1939, OF THE FIVE FLATHEAD-INFESTED TREES APPEARING IN GROUPS, THREE APPEARED TO HAVE HAD A KEY ROLE IN DEVELOPMENT OF THREE GROUP INFESTATIONS. SEVEN OF THE TWELVE SUMMER TREES FORMING PARTS OF SUMMER-WINTER GROUPS WERE FELLED FOR ANALYSIS, BUT NONE OF THESE REVEALED THE PRESENCE OF FLATHEAD INFESTATIONS. IN ADDITION TO THREE FLATHEAD "KEY" TREES, ONE TREE WAS FOUND IN WHICH DENDROCTONUS MONTICOLAE APPEARED TO HAVE INITIATED AN ATTACK THAT RESULTED IN A GROUP INFESTATION OF THREE TREES.

COMPARISON OF INFESTATIONS BETWEEN SINGLE TREES WITH TOPKILLS AND SINGLE TREES WITHOUT TOPKILLS

IF ONE DISREGARDS THE ORIGINAL TOPKILLING INFESTATIONS IN SINGLE TREES, THE FOLLOWING COMPARISONS CAN BE MADE. FROM TABLE 6 IT WILL BE SEEN THAT THE CLASS OF TOPKILLED TREES SUFFERED INITIAL ATTACKS BY A GREATER NUMBER OF SPECIES THAN DID THE CLASS OF SINGLE TREES WITHOUT TOPKILLS. IN 1939 SINGLE TOPKILLED TREES WERE ATTACKED INITIALLY BY ALL FOUR SPECIES, DENDROCTONUS BREVICOMIS, MELANOPHILA CALIFORNICA, IPS OREGONI AND DENDROCTONUS MONTICOLAE, AND IN 1940 BY THE THREE SPECIES, D. BREVICOMIS, M. CALIFORNICA AND I. OREGONI. IN THE SINGLE TREES WITHOUT TOPKILLS, IN 1939 D. BREVICOMIS, M. CALIFORNICA AND D. MONTICOLAE WERE THE INITIAL ATTACKING SPECIES, WHEREAS IN 1940 THE ONLY SINGLE TREES WITHOUT TOPKILLS THAT SUCCUMBED WERE THOSE IN WHICH M. CALIFORNICA APPEARED TO HAVE BECOME ACTIVE FIRST; ALTHOUGH THESE SAME TREES ALL CONTAINED D. BREVICOMIS AS A SUPPLEMENTAL SPECIES, AND I. OREGONI IN 54.5% OF THE CASES. IN 1940 THE INCIDENCE OF M. CALIFORNICA WAS HIGHER IN BOTH CLASSES OF TREES THAN IN 1939.

TABLE 6. INCIDENCE OF SPECIES AS INITIATORS OF ATTACKS IN SINGLE TOPKILLED TREES AND IN SINGLE PERFECT-TOPPED TREES IN 1939 AND 1940. (IN PERCENTS OF TOTAL TREES IN EACH CLASS.)

	With Topkills					Without Topkills				
Year	Mc	Db	Io	Dm	Total	Mc	Db	Io	Dm	Total
1940	81.0	9.5	9.5	-	100.0	100.0	-	-	-	100.0
1939	54.5	18.2	9.1	18.2	100.0	61.5	23.1	-	15.4	100.0

Insect Relations in Topkills

No very exact data on the causes or factors that prevailed in conjunction with topkilling of the trees are presentable. Many of the topkills were in a condition that prevented identification of the factors associated with their formation.

Table 7, however, shows the incidences of the species that appeared to have initiated the insect successions in the topkills. In both years a high percentage of the topkills fell into the "unknown" category. This large percentage of "unknowns" may conceal any actual changes in the incidence of either flatheads or Ips oregoni during the two years. Likewise, the topkilled trees represent the accumulated topkillings of a number of years, and it is possible that year to year fluctuations in the incidence of various species would not be very perceptible in the topkill sample that is represented in the series of stem analysis records of the composition studies.

There is an increase in the incidence of flatheads in topkills from 1939 to 1940. This may possibly be related to a high incidence of 1939 topkilling that showed up in 1940. Topkills of the 1939 season comprised 28.5% of the topkills encountered in 1940, and all but one of these were associated with flathead emergence. All of the 1939 topkilled trees showing flathead emergence from the topkills succumbed in 1940 with Melanophila californica-Dendroctonus brevicomis infestations, the M.c. broods having been first to begin their development in the two-species successions.

Ips oregoni incidence in topkills shows a considerable decrease from 1939 to 1940, but the change in these percentages may have no significance. It may be worthy of note that all of the trees in 1940 and in 1939 showing positive Ips topkills subsequently died with D.b. or Ips and D.b. infestations.

Table 7. Incidences of Insect Species Associated with Topkilling in Single Trees in 1939 and 1940 (by percent)

Year	Mc	Io	Unknown	Total
1940	52.3	4.8	42.9	100.0
1939	45.5	18.2	36.4	100.0

SUMMARY

THE RESULTS OF THE COMPOSITION STUDIES OF 1940 WINTER TREES MAY BE SUMMARIZED BRIEFLY:

1. THE 1940 WINTER INFESTATION IS VERY LIGHT, AND ABOUT 3/4 OF THE LOSSES ARE IN SINGLE TREES. ALMOST $\frac{1}{2}$ OF THE TREE LOSSES, ALSO, ARE TOPKILLED TREES.

2. THE LOSSES ARE HEAVIEST ON THE EAST EDGE OF THE BADGER TOWNSHIP, AND SEEM TO BE DISTRIBUTED WITHOUT RELATION TO THE SITE CLASS.

3. THE LOSSES ARE IN TREES OF LARGER AVERAGE BOARD MEASURE VOLUME THAN IN 1939.

4. GROUPING TENDENCIES REACHED THEIR CLIMAX IN 1939 SUMMER AND WINTER SEASONS, AND HAVE FALLEN TO A LOW POINT SINCE, ESPECIALLY SINCE 1940 SUMMER.

5. ALL THE FOUR SPECIES FOUND INITIATING ATTACKS IN 1939 SHOWED CONSIDERABLE DECLINES IN THE AMOUNT OF THEIR INFESTATION, IN BOARD MEASURE VOLUME PER ACRE, FROM 1939 TO 1940. THIS DROP WAS GREATER FOR SOME SPECIES THAN FOR OTHERS.

6. DENDROCTONUS BREVICOMIS LEC. ACTIVITY APPEARS TO HAVE DROPPED VERY MUCH, IN B.M. VOLUME PER ACRE, AND RELATIVE TO THE OTHER SPECIES. ITS ACTIVITY WAS AT ITS HIGHEST IN 1939.

7. MELANOPHILA CALIFORNICA VAN DYKE ACTIVITY DROPPED CONSIDERABLY FROM 1939 TO 1940, BUT NOT AS GREATLY AS D. BREVICOMIS. RELATIVE TO THE OTHER SPECIES, M. CALIFORNICA ACTIVITY INCREASED FROM 1939 TO 1940 IN THE NUMBER OF INFESTATIONS IT INITIATED.

8. IPS OREGONI (EICH.) SHOWS LESS OF A DROP FROM 1939 TO 1940 THAN D. BREVICOMIS, ITS ACTIVITY BEING RELATIVELY HIGHER IN THE 1940 SEASON THAN IN 1939. BUT THE ONLY ACTUAL INCREASE IN ACTIVITY SEEMED TO HAVE TAKEN PLACE IN THE HACKAMORE AREA IN ASSOCIATION WITH THE LOGGING OPERATIONS THERE.

9. OTHER SPECIES HAD A VERY SMALL PART IN THE INFESTATIONS IN 1940.